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(71)(72) Applicants and Inventors: KALVINSH, Ivars [LV/LV]; Apartment 8, Micra 17, LV-2169 Salaspils (LV). VEVERIS, Maris [LV/LV]; Apartment 20, Vejavas 10/2, LV-1035 Riga (LV).

(74) Agent: FOGEL, Abraham; Alfa-Patents, Marstalu 2/4, LV-1050 Riga (LV).

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(54) Title: PHARMACEUTICAL COMPOSITIONS CONTAINING GAMMA-BUTYROBETAIN FOR TREATMENT OF BLOOD FLOW DISORDERS

(57) Abstract

The invention relates to γ-butyrobetaine-containing pharmaceutical compositions for oral, parenteral, subcutaneous or rectal administrations, that are providing for the treatment blood circulation disturbances of various genesis and localisation. This composition in the experiments on anaesthesized cats at a dose of 10 mg/kg, i.v. increases the total blood flow by 12 %, not considerably changing blood pressure and heart rhythm. The composition arrests adrenaline-induced isolated rabbit ear blood-vessel spasms. In a concentration of 2.0 mM it decreases reperfusion pressure by 18 %. NO-synthase blocking reverses the composition effect on adrenaline-caused blood-vessel spasms. Being infused the composition at a dose of 200 mg/kg significantly increases blood coagulation during phases I-II. In the comparative experiments the disclosed composition demonstrates more potent effect compared to known medicine [3-(2,2,2-trimethylhydrazinium)propionate]. The preparation is distinguished by a low toxicity and wide safety margin.

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DESCRIPTION

PHARMACEUTICAL COMPOSITIONS CONTAINING GAMMA-BUTYROBETAIN FOR TREATMENT OF BLOOD FLOW DISORDERS

TECHNICAL FIELD

The present invention relates to pharmaceutical compositions, namely to the pharmaceutical compositions which are providing for treatment of blood flow disturbances of various genesis and localisation. The therapeutic composition contains the known chemical substance, the novel action of which gives unexpected pharmacological effects, namely, there is disclosed pharmaceutical composition which contains γ–butyrobetaine as an active principle in a combination with pharmaceutically acceptable fillers and/or solvents.

BACKGROUND ART

γ–Butyrobetaine (actinine), from which the mammalian organism synthesises carnitine, was primarily characterised as a toxic substance which accelerates respiration, causes salivation and lacrimation, pupil dilation, vasoconstriction and heart stop in diastole (W.Linneweh, Z.Physiol.Chern., 42,181,1929). At the same time, in later papers other authors ascertained that γ–butyrobetaine is extremely low toxic (LD_{50} 7000 mg/kg, s.c.). (W.Rotzsch, L.Lorenz,E.Strack, Acta biol.med.ger. 1959, 3, 28-36). Literature lacks the data on cardiovascular effects of γ–butyrobetaine, though it was reported (Hosein E.A., McLennan H. Pharmacological action of γ– butyrobetaine. Nature, 1956, 183, 328-329) that butyrobetaine is a substance similar to acetyl choline with a

prolonged action. However, later the same authors reported that by an error the experiments involved, instead of γ– butyrobetaine, its methyl esther which in fact possesses cholinergic properties. Contrary to the former γ–butyrobetaine was characterised as a pharmacologically inert substance (E.A.Hoseln, P.Proulx, Isolation and probable functions of betaine esters in brain metabolism, Nature, 1960, 187, 321-322. A.S.V.Burgen, F.Hobiger. Brit.J.Pharmacol., 1949, 4, 229. E.Strack, K.Foesterling. Z. Physiol. Chem., 1953,295, 377

The closest structural analogue of γ–butyrobetaine which is used for the treatment of cardiovascular diseases is γ–betaine aza-analog - 3-(2,2,2-trimethylhydrazinium)propionate (Mildronate, Quaterine). Its mechanism of action is based on limitation of carnitine biosynthesis rate and related long–chain fatty acid transport decrease through mitochondria membranes [Simkhovich B.Z., Shutenko Z.V., Meirena D.V. et al. 3-(2,2,2-trimethylhydrazinium)propionate (THP) - a novel γ–butyrobetaine inhibitor with cardioprotective properties. Biochem.Pharmacol. 1988, 37, 195-202].

DISCLOSURE OF THE INVENTION

The cardiovascular activity and the toxicity of pharmaceutical compositions containing γ–butyrobetaine was determined.

Acute toxicity was evaluated on male and female mice (19-26 g), 10 animals in a group. The substances were administered in the form of 10% solution in water or in isotonic solution orally or intravenously (with 0.004 ml/sec rate, if i.v.). It was established that at oral administration LD_{50} of γ–butyrobetaine is >4500 mg/kg, but at intravenous injection LD_{50} is 1860(1430-2418) mg/kg, which testifies that γ–butyrobetaine is practically non-toxic substance. Special experiments on cats demonstrated that the pharmaceutical compositions containing purified γ–butyrobetaine at a dose 186 times lower than toxic possesses a stronger effect on blood vessel tonus and blood flow than the known preparation and closest structural analogue Mildronate, and, contrary to acetyl choline, there are not observed blood pressure decrease and heart rate decline, while blood flow essentially increases (Table 1).

Table 1. Influence of 3-(2,2,2-trimethylhydrazine)propionate (M), γ-butyrobetaine (GBB) and acetylcholine (Ach) on haemodynamics in anaesthesized cats

Substance	Dose, i.v., mg/kg	Blood pressure changes, %	Pulse rate changes	Blood flow rate changes, %
M	5.0	- 3	- 3	+ 5
M	10.0	- 5	- 3	+ 8*
GBB	5.0	- 4	- 5	+ 6
GBB	10.0	-7 - +3	- 5	+ 12**
Ach	0.001	-35*	-20*	- 8

* $p<0.05$ vs the initial parameters
** $p<0.05$ vs the corresponding M dose

The experiments were performed on male and female (2.9-3.8 kg) anaesthetised cats (urethane (200mg/kg) and chloralose (50 mg/kg), both i.p.).

The chest was opened in the experimental animals, they were artificially respirated, and blood pressure in the carotid artery as well as general aorta blood flow were measured on physiograph DMP-4B of "Narco Bio-Systems", USA.

If the observed γ–butyrobetaine effect on the blood flow was connnected with earlier erroneously attributed cholinergic component which, mainly relates to γ–butyrobetaine ester (The Merck Index, Eleventh Edition, 1871) impurities in the samples of insufficiently purified γ–butyrobetaine, then one would anticipate a significant decrease in the blood pressure and heart rate (see acetyl choline effect, Table I). The observed cardiovascular effect indicates a positive inotropic effect of the proposed therapeutic composition with simultaneous peripheral resistance decrease

by a completely another mechanism, which can be used in the treatment of low heart potency and of blood circulation disturbances of various genesis.

In the experiments with isolated rabbit ear blood vessels the pharmaceutical composition which contains γ–butyrobetaine was 2-3 times more potent in adrenaline-induced blood vessel spasm than the closest structural analogue - the known preparation 3-(2,2,2-trimethylhydrazinium)propionate (M).

Table 2. Influence of 3-(2,2,2-trimethylhydrazine)propionate (M) and γ-butyrobetaine (GBB) on the blood vessels spasms induced by adrenaline in the isolated rabbit's ear

Substance concentration (mM)	Systolic pressure (mm Hg) max/min				Decrease of the systolic pressure, %
	Initial parameters		Parameters after adrenaline injection 3.10^{-7} M		
	max	min	max	min	
M, 0.3	38±5	8±2	125	80	1
M, 1.0	38±5	8±2	123	77	4
M, 2.0	38±5	8±2	126	80	8*
GBB, 0.3	38±5	8±2	124	76	6
GBB, 1.0	38±5	8±2	125	80	15*
GBB, 2.0	38±5	8±2	125	78	18*

* $p<0.05$
** $p<0.01$

It was unexpectedly discovered that in the basis of this vasodilating effect lies NO-synthase activation which is completely blocked by L-NO_2-arginine (Table 3).

Table 3. Influence of 3-(2,2,2-trimethylhydrazine)propionate (M) and γ-butyrobetaine (GBB) on the blood vessels spasms induced by adrenaline in the presence of L-nitroarginine (L-NO_2-Arg) (10 mg/l) in the isolated rabbit's ear

Substance concentration (μM)	Systolic pressure (mm Hg) max/min				Decrease of the systolic pressure, %
	Initial parameters		Parameters after adrenaline injection 3.10^{-7} M		
	max	min	max	min	
M, 0.3	36±5	7±2	165	102	0
M, 1.0	36±5	7±2	163	100	0
M, 2.0	36±5	7±2	165	100	2
GBB, 0.3	36±5	8±2	168	105	0
GBB, 1.0	36±5	8±2	165	100	0
GBB, 2.0	36±5	8±2	163	100	0

* $p<0.05$ vs the initial parameters

γ–Butyrobetaine also affects blood coagulation time. This was determined in male ICE-JCL albino mice (24-28 g), 10 mice in a group, using Moravic's method (Thodorov Y. Khlinicheskye laboratornie issledovania v pediatrii, Medic.Phys.", Sophia, 1966, p.p.479-480, in Russian). Time when fibrin strings develop was determined. The blood was sampled from jugular vein, mice were preliminarily anaesthetized with urethane (1000 mg/kg, i.p.). The solutions of the substances were infusively administered directly before detection of the blood coagulation time.

Table 4 shows that γ–butyrobetaine considerably prolongs blood coagulation I-II phase, i.e. the time when fibrin strings develop. This means that pharmaceutical compositions on the butyrobetaine basis can be applied in the therapy of such blood circulation failures which are connected with thrombus formation and thrombus embolia.

Table 4. Influence of γ-butyrobetaine (GBB) on blood coagulation time in mice (after Moravica)

Substance, dose (mg/kg)	Coagulation time (sec)
GBB, 200 mg/kg, injection	46 + 5.5*
Control (isotonic solution)	23.75 +3.4

*p<0.05

Thus, we have unexpectedly discovered that the pharmaceutical composition on the basis of γ–butyrobetaine possesses a wide spectrum of vascular action which is connected with its effect on blood vessel and miocardium tonus as well on NO-synthase, being more potent than known preparation Mildronate which is a close γ–butyrobetaine structural analogue. Hence, the pharmaceutical composition containing γ–butyrobetaine is a promising agent for the treatment of blood flow disturbances of various genesis. The preparation can be administered both orally, parenterally, rectally or transcutaneously.

In the case the active principle is administered as injection or orally in the form of drops, syrup or drink the pharmaceutical composition contains γ–butyrobetaine in the total amount of 0.5 to 40% by weight, and as a pharmaceutically acceptable solvent - distilled water, isotonic or glucose or buffer solution.

In the case the active principle is administered orally or sublingually in tablets, caplets, dragee, granules, powders or capsules they contain γ–butyrobetaine in total amount of 0.01 to 0.5 g in a tablet, caplet, dragee, capsule or in one portion of powder or granule.

In the case the active principle are administered transcutaneously its content in an ointment or plaster makes up 0.5 to 40% by weight. In the case the active principle is administered rectally its content in a suppository or microenema accounts for 0.5 to 40% by weight.

CLAIMS

1. A pharmaceutical composition for the treatment of blood flow disturbances, which contains γ–butyrobetaine as an active principle and pharmaceutically acceptable carrier.

2. The pharmaceutical composition according to Claim 1, wherein the composition contains 0.5-95% of γ–butyrobetaine by weight.

3. The pharmaceutical composition according to Claim 1 or 2 wherein it is intended for oral or sublingual administration and is in the form of tablets (with or without a cover), capsules, caplets, dragees, granules, powder or solution, which contain 0.01-0.5g of active principle by weight in every tablet, capsule, dragee, granule or powder dose, or also this is a 0.5-40% solution or syrup for oral administration.

4. The pharmaceutical composition according to Claim 3, wherein the acceptable carrier is selected from the group of substances which consist of stearinic acid and its salts, lactose, glucose, saccharose, starch, talc, vegetable oils, polyethylene glycols, microcrystalline cellulose, aerosil, aromatizers, flavoring agents, colorants, ethyl alcohol and water, which are taken separately or are used in combinations.

5. The pharmaceutical composition according to Claim 1, wherein it is designed for parenteral administration and it has a solution form for injections, which contain 0.5-40% of the active principle by weight and pharmaceutically acceptable solvent.

6. The pharmaceutical composition according to Claim 5, wherein a pharmaceutically acceptable solvent is selected from the group of solvents which contain a distilled water, isotonic solution, buffer solution or glucose solution, which are taken separately or are used in combinations.

7. The pharmaceutical composition according to Claim 1 or 2, wherein it is intended for transcutaneous administration of the active

principle and it is in the form of ointment, solution or plaster, which contains 0.5-40% of the active principle by weight and pharmaceutically acceptable carrier.

8. The pharmaceutical composition according to Claim 7, wherein the pharmaceutically acceptable carrier is chosen from the group which consists of water, polyethylene glycols 400, 1500 and 4000, vegetable oils, fats, glycerine, preservants, emulgators, stabilisers, porous polymer material, dimethylsulphoxide, alcohol and water which are taken separately or are used in combinations.

9. The pharmaceutical composition according to Claim 1 or 2, wherein the it is meant for rectal administration of the active principle in the form of suppositories or microenema, which contain 0.5-40% of the active principle by weight and pharmaceutically acceptable carrier.

10. The pharmaceutically composition according to Claim 9, wherein the pharmaceutically acceptable carrier is selected from the groups which consists of water, polyethylene glycols 400, 1500 and 4000, vegetable oils, fats, glycerine, preservants, emulgators and stabilisers, which are taken separately or used in combinations.

AMENDED CLAIMS

[received by the International Bureau on 16 January 1997 (16.01.97); original claim 1 amended; remaining claims unchanged (1 page)]

1. A pharmaceutical composition for the treatment of blood flow disturbances, not induced by L-carnitine deficiency, which contains γ-butyrobetaine as an active principle and pharmaceutically acceptable carrier.

2. The pharmaceutical composition according to Claim 1, wherein the composition contains 0.5-95% of γ-butyrobetaine by weight.

3. The pharmaceutical composition according to Claim 1 or 2 wherein it is intended for oral or sublingual administration and is in the form of tablets (with or without a cover), capsules, caplets, dragees, granules, powder or solution, which contain 0.01-0.5g of active principle by weight in every tablet, capsule, dragee, granule or powder dose, or also this is a 0.5-40% solution or syrup for oral administration.

4. The pharmaceutical composition according to Claim 3, wherein the acceptable carrier is selected from the group of substances which consist of stearinic acid and its salts, lactose, glucose, saccharose, starch, talc, vegetable oils, polyethylene glycols, microcrystalline cellulose, aerosil, aromatizers, flavoring agents, colorants, ethyl alcohol and water, which are taken separately or are used in combinations.

5. The pharmaceutical composition according to Claim 1, wherein it is designed for parenteral administration and it has a solution form for injections, which contain 0.5-40% of the active principle by weight and pharmaceutically acceptable solvent.

6. The pharmaceutical composition according to Claim 5, wherein a pharmaceutically acceptable solvent is selected from the group of solvents which contain a distilled water, isotonic solution, buffer solution or glucose solution, which are taken separately or are used in combinations.

7. The pharmaceutical composition according to Claim 1 or 2, wherein it is intended for transcutaneous administration of the active

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61K31/205

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 382 092 (CLAUDIO CAVAZZA) 3 May 1983	1,3
Y	see column 1, line 7 - line 18 see column 3, line 27 - column 4, line 60	2,4-10
X	US,A,5 030 458 (AUSTIN L. SHUG ET AL.) 9 July 1991	1
Y	see column 2, line 10 - line 17	2-10
Y	see column 5, line 51 - column 6, line 63	2-10
Y	US,A,4 474 812 (CLAUDIO CAVAZZA) 2 October 1984 see column 1, line 5 - line 24 see column 4, line 10 - line 11	1-10
Y	US,A,4 451 485 (IVARS Y. KALVISH ET AL.) 29 May 1984 see column 2, line 4 - line 9	1-10

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[X] Further documents are listed in the continuation of box C.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DATABASE WPI Section Ch, Week 8940 Derwent Publications Ltd., London, GB; Class B05, AN 89-289767 XP002017003 & JP,A,01 213 259 (KYOWA HAKKO KOGYO KK) , 28 August 1989 see abstract	1-10
Y	ACTA BIOL. MED. GERM., vol. 35, no. 5, 1976, pages 645-656, XP002017002 E.STRACK ET AL.: "L-Karnitin als Basis cholinomimetischer Substanzen" see abstract	1-10

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Information on patent family members

International Application No
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